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Kawano

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(54) **IMAGE PROCESSING APPARATUS**

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H04N 1/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H04N 1/00702*** (2013.01); ***H04N 1/00718*** (2013.01); ***H04N 1/00742*** (2013.01); ***H04N 1/00769*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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(57) **ABSTRACT**

An image processing apparatus, includes: an acceptance unit that accepts image data and reading data; an extraction unit that extracts rectangular images by segmenting one image of the image data and the reading data; a first searching unit that selects at least one of the rectangular images extracted by the extraction unit, set a search range calculated from the error, searches for a matching position of the selected rectangular image in the other image of the image data and the reading data; an estimation unit that estimates a matching position of a rectangular image in the other image on the basis of the matching position of the selected rectangular image in the other image; and a second searching unit that searches for a matching position of the other rectangular image in the other image using the matching position estimated by the estimation unit as a reference.

8 Claims, 10 Drawing Sheets

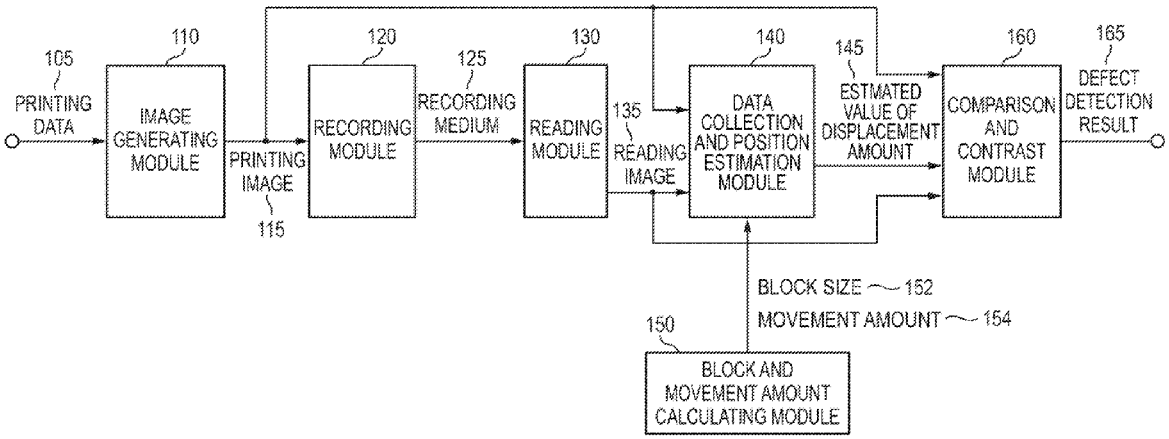


FIG. 1

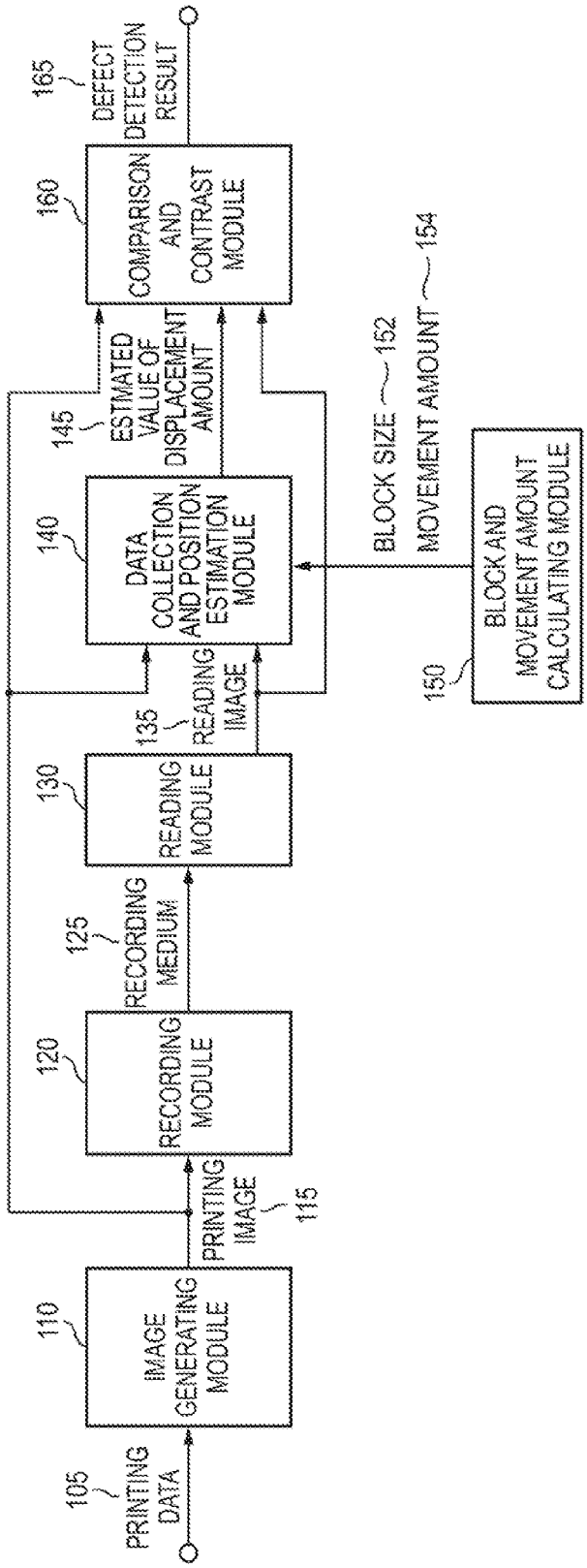

105
PRINTING DATA
110
IMAGE GENERATING MODULE
115
PRINTING IMAGE
120
RECORDING MODULE
125
RECORDING MEDIUM
130
READING MODULE
135
READING IMAGE
140
DATA COLLECTION AND POSITION ESTIMATION MODULE
145
ESTIMATED VALUE OF DISPLACEMENT AMOUNT
150
BLOCK AND MOVEMENT AMOUNT CALCULATING MODULE
152
BLOCK SIZE
154
MOVEMENT AMOUNT
160
COMPARISON AND CONTRAST MODULE
165
DEFECT DETECTION RESULT

FIG. 2

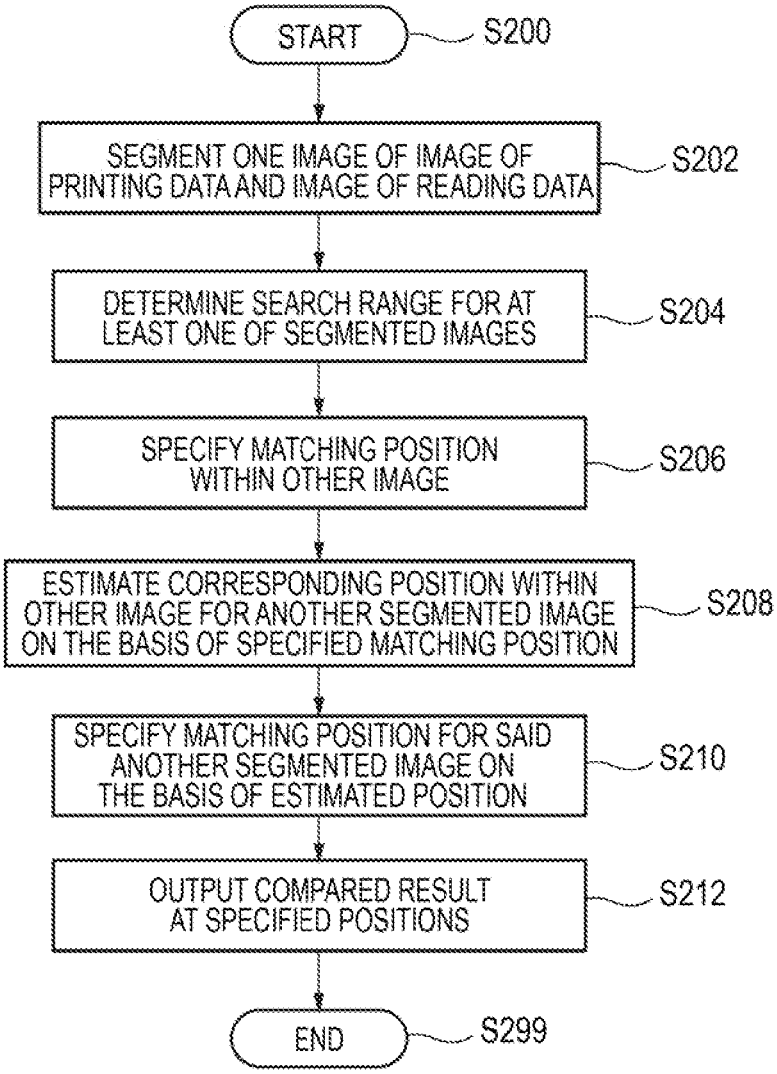

START
S200
SEGMENT ONE IMAGE OF IMAGE OF PRINTING DATA AND IMAGE OF READING DATA
S202
DETERMINE SEARCH RANGE FOR AT LEAST ONE OF SEGMENTED IMAGES
S204
SPECIFY MATCHING POSITION WITHIN OTHER IMAGE
S206
ESTIMATE CORRESPONDING POSITION WITHIN OTHER IMAGE FOR ANOTHER SEGMENTED IMAGE ON THE BASIS OF SPECIFIED MATCHING POSITION
S208
SPECIFY MATCHING POSITION FOR SAID ANOTHER SEGMENTED IMAGE ON THE BASIS OF ESTIMATED POSITION
S210
OUTPUT COMPARED RESULT AT SPECIFIED POSITIONS
S212
END
S299

FIG. 3

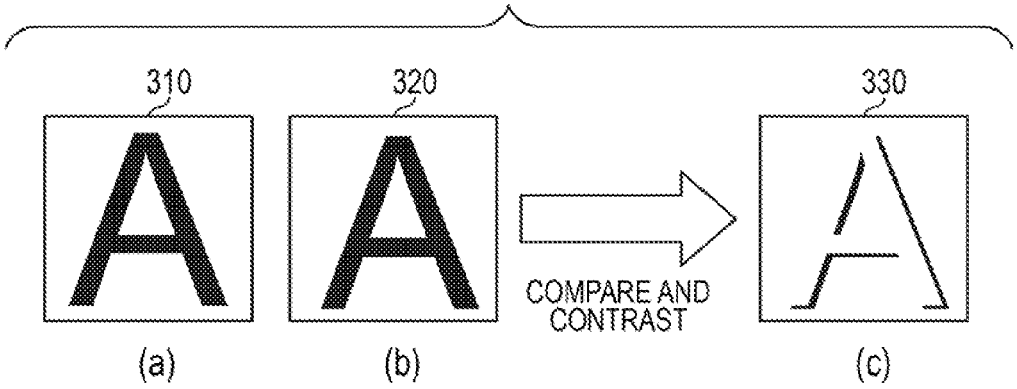


FIG. 4

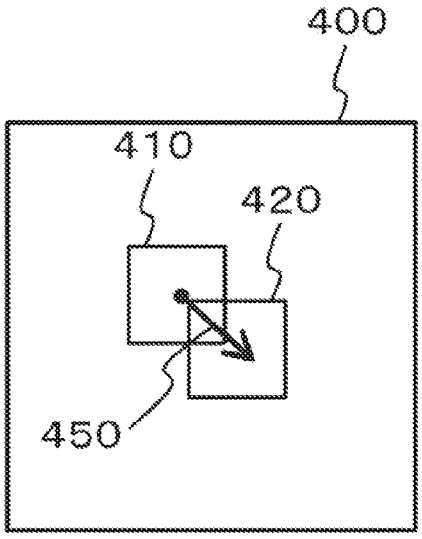


FIG. 5

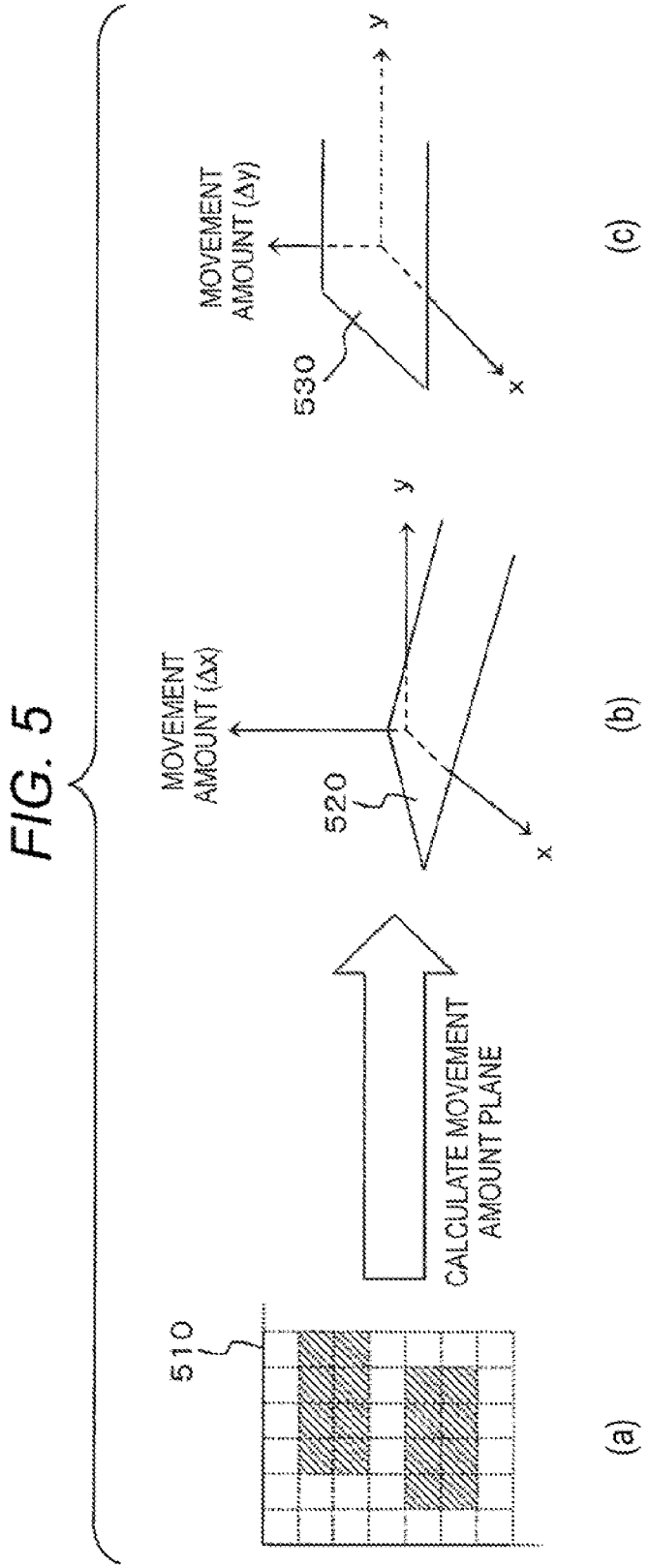
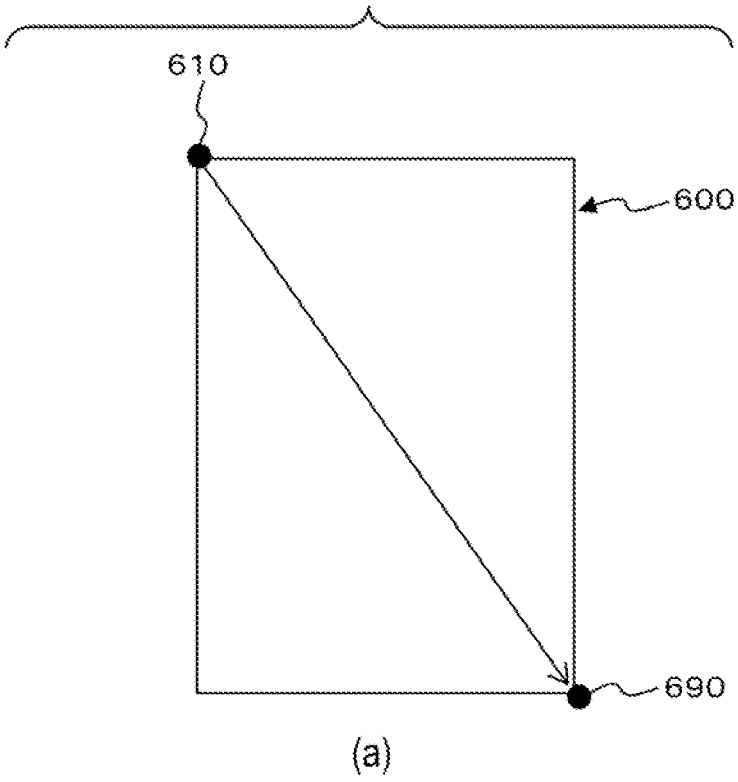
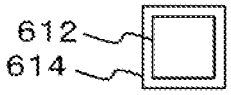

510
CALCULATE MOVEMENT AMOUNT PLANE
520
MOVEMENT AMOUNT (Δx)
y
x
530
MOVEMENT AMOUNT (Δy)
y
x
(a)
(b)
(c)

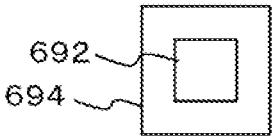
FIG. 6



(a)



(b)



(c)

FIG. 7

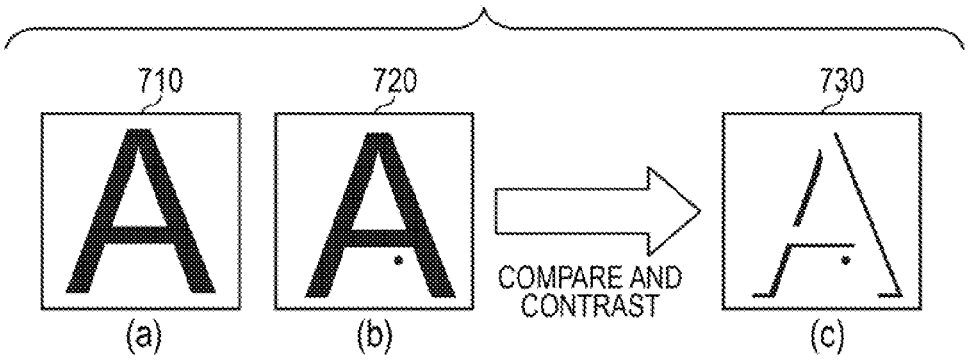

710
720
730
COMPARE AND CONTRAST
(a)
(b)
(c)

FIG. 8

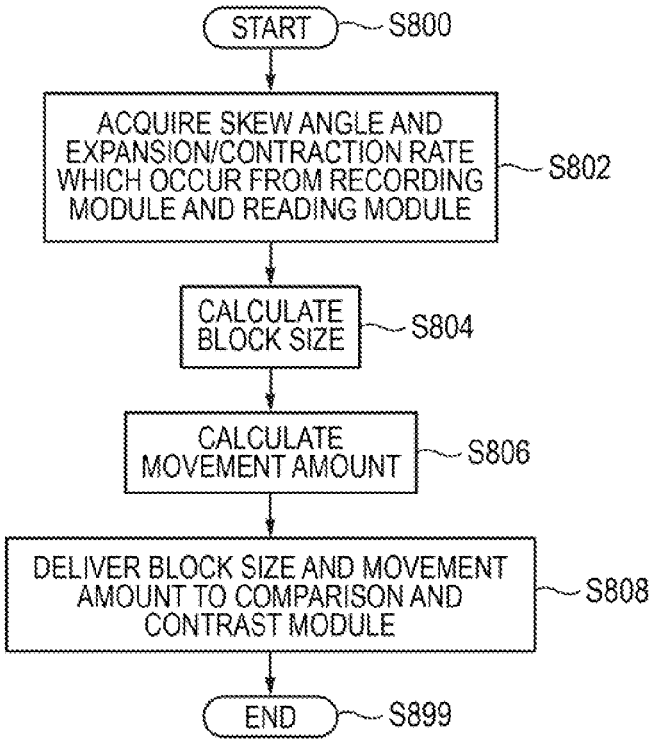

START
S800
ACQUIRE SKEW ANGLE AND EXPANSION/CONTRACTION RATE WHICH OCCUR FROM RECORDING MODULE AND READING MODULE
S802
CALCULATE BLOCK SIZE
S804
CALCULATE MOVEMENT AMOUNT
S806
DELIVER BLOCK SIZE AND MOVEMENT AMOUNT TO COMPARISON AND CONTRAST MODULE
S808
END
S899

FIG. 9

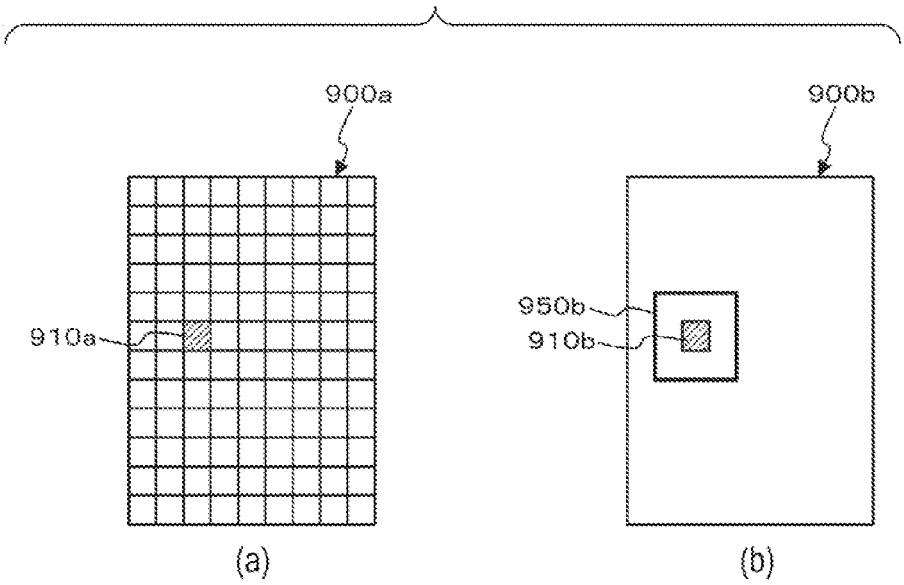


FIG. 10

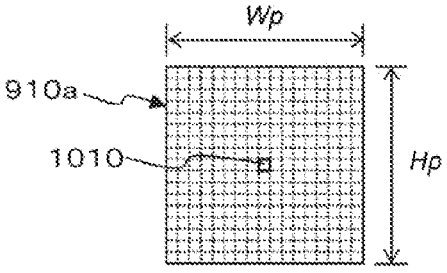


FIG. 11

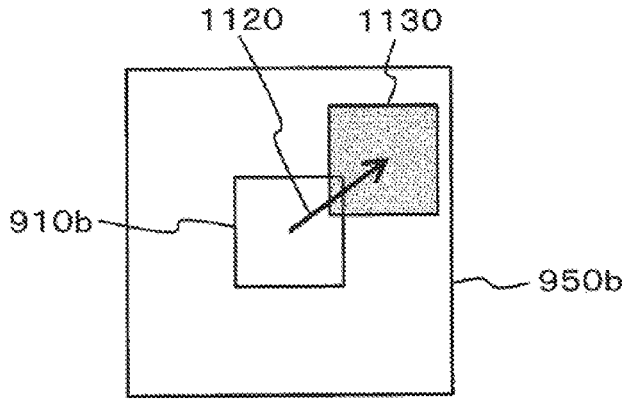


FIG. 12

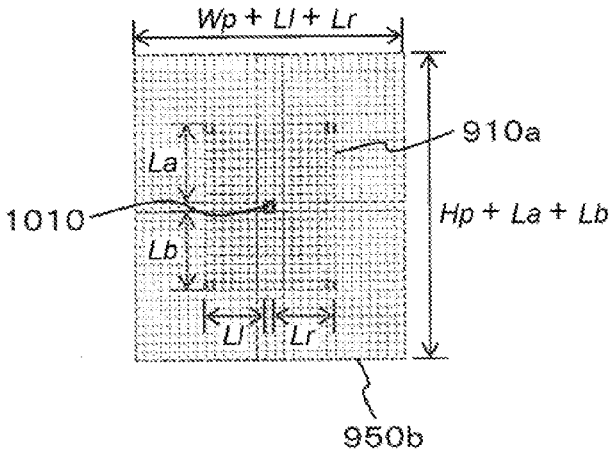


FIG. 13

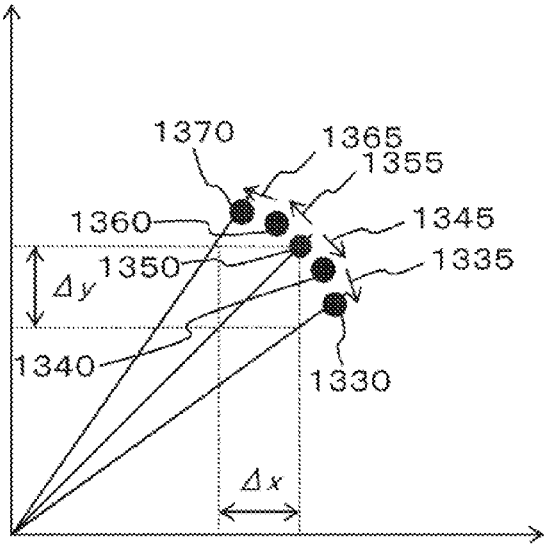


FIG. 14

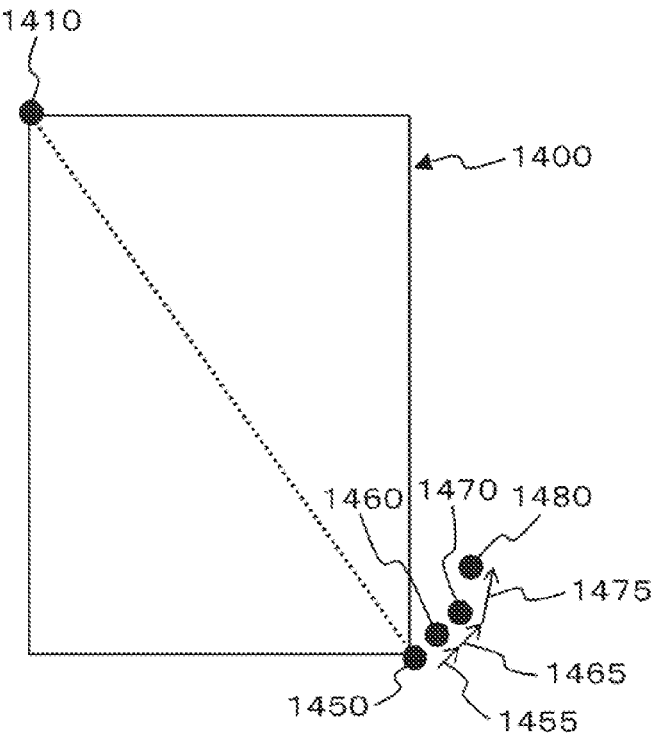

1410
1400
1460
1470
1480
1475
1465
1450
1455

FIG. 15

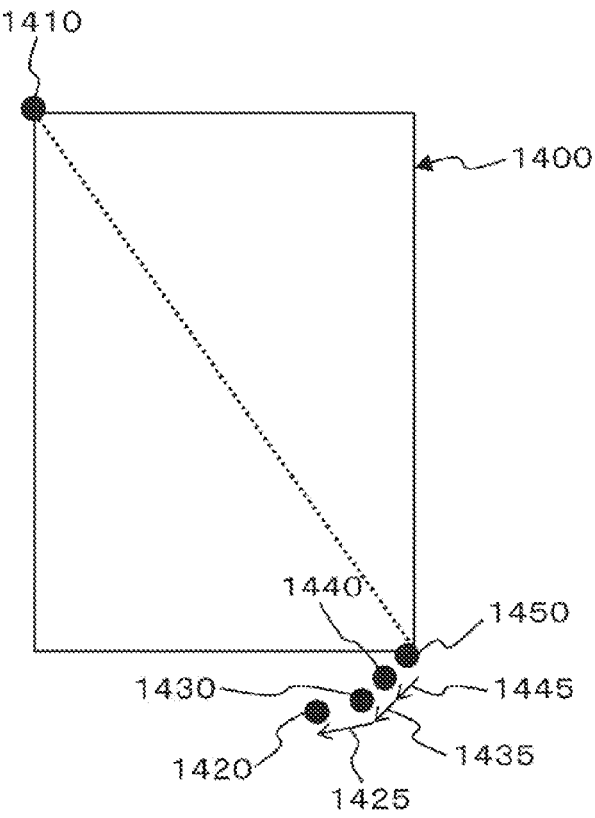

1410
1400
1440
1450
1430
1445
1435
1420
1425

FIG. 16

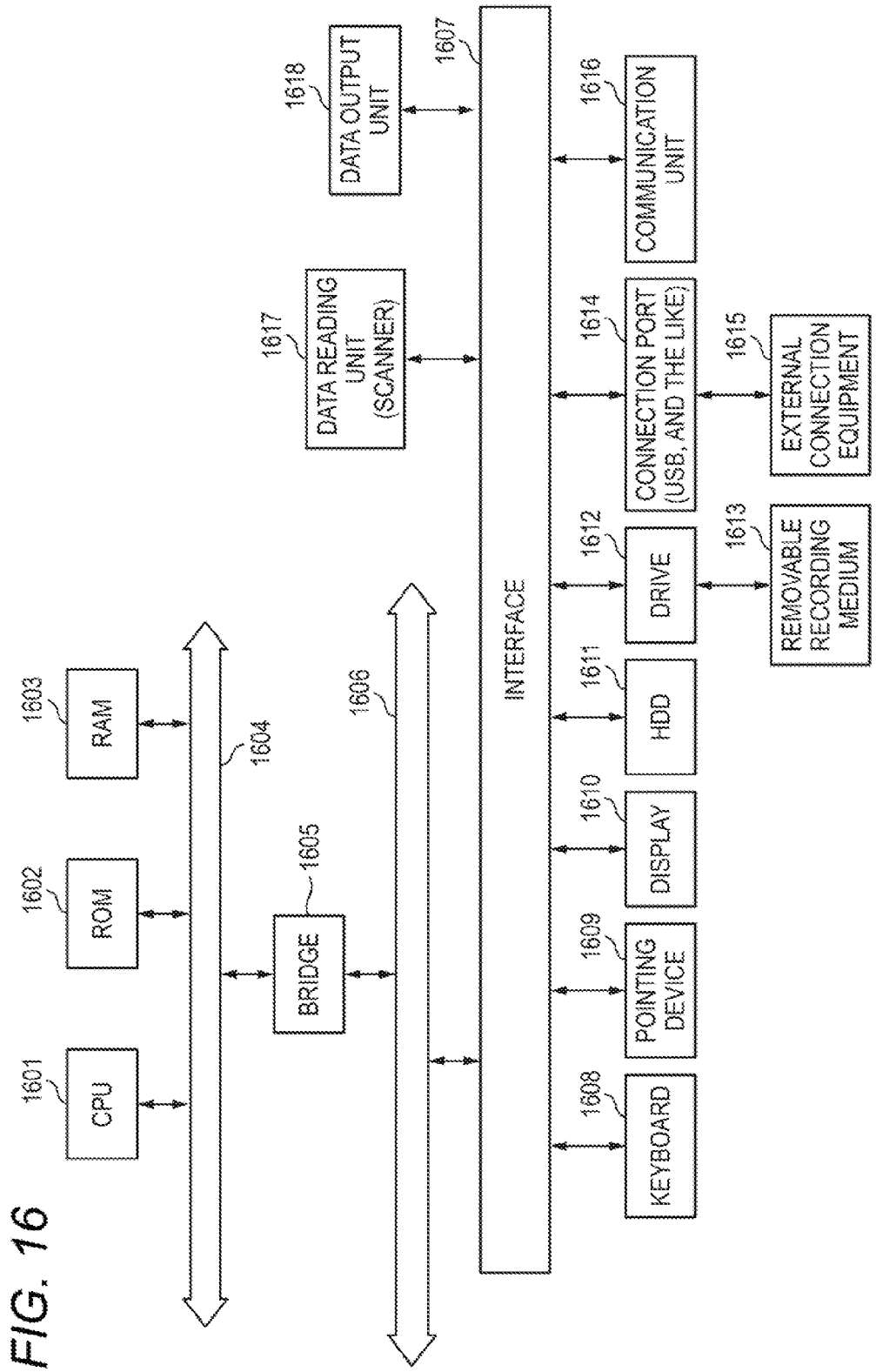

1601
CPU
1602
ROM
1603
RAM
1604
1605
BRIDGE
1606
1607
INTERFACE
1608
KEYBOARD
1609
POINTING DEVICE
1610
DISPLAY
1611
HDD
1612
DRIVE
1613
REMOVABLE RECORDING MEDIUM
1614
CONNECTION PORT (USB, AND THE LIKE)
1615
EXTERNAL CONNECTION EQUIPMENT
1616
COMMUNICATION UNIT
1617
DATA READING UNIT (SCANNER)
1618
DATA OUTPUT UNIT

IMAGE PROCESSING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority under 35 U.S.C. 119 from Japanese Patent Application No. 2013-215728 filed on Oct. 16, 2013, and Japanese Patent Application No. 2014-192402 filed on Sep. 22, 2014.

BACKGROUND

Technical Field

The present invention relates to an image processing apparatus.

SUMMARY

According to an aspect of the present invention, it provides an image processing apparatus, including: an acceptance unit that accepts image data and reading data read from a medium on which an image of the image data is formed; an extraction unit that extracts rectangular images by segmenting one image of the image data and the reading data to have a size calculated based on an error which occurs from an image forming apparatus forming the image of the image data on the medium and/or an image reading apparatus reading the medium; a first searching unit that selects at least one of the rectangular images extracted by the extraction unit, set a search range calculated from the error, searches for a matching position of the selected rectangular image in the other image of the image data and the reading data; an estimation unit that estimates a matching position of a rectangular image in the other image on the basis of the matching position of the selected rectangular image in the other image; a second searching unit that searches for a matching position of the other rectangular image in the other image using the matching position estimated by the estimation unit as a reference; and a comparison unit that compares the rectangular image extracted by the extraction unit with the rectangular image in the other image at the position searched by the first and second searching units.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiment(s) of the present invention will be described in detail based on the following figures, wherein

FIG. **1** is a conceptual module configuration diagram of an embodiment of the present invention;

FIG. **2** is a flow chart illustrating a processing example according to the embodiment of the present invention;

FIG. **3** is an explanation diagram illustrating a processing example in a data collection and position estimation module;

FIG. **4** is an explanation diagram illustrating the processing example in the data collection and position estimation module;

FIG. **5** is an explanation diagram illustrating the processing example in the data collection and position estimation module;

FIG. **6** is an explanation diagram illustrating an example of a size of a search range based on a position within an image;

FIG. **7** is an explanation diagram illustrating a processing example of detecting a defect;

FIG. **8** is a flow chart illustrating a processing example of calculating a block size and a movement amount;

FIG. **9** is an explanation diagram illustrating the processing example according to the embodiment of the present invention;

FIG. **10** is an explanation diagram illustrating a block example;

FIG. **11** is an explanation diagram illustrating the processing example using a comparison and contrast module;

FIG. **12** is an explanation diagram illustrating a relation example between a block image and a search range;

FIG. **13** is an explanation diagram illustrating the processing example of calculating the block size;

FIG. **14** is an explanation diagram illustrating the processing example of calculating the movement amount;

FIG. **15** is an explanation diagram illustrating the processing example of calculating the movement amount; and

FIG. **16** is a block diagram illustrating a hardware configuration example of a computer realizing the present embodiments.

DETAILED DESCRIPTION

Hereinafter, an example of one embodiment suitable to realize the present invention will be described with reference to the accompanying drawings.

FIG. **1** illustrates a conceptual module configuration diagram of a configuration example according to the present embodiment.

Meanwhile, a module generally indicates parts such as logically separable software (computer program) and hardware. Therefore, the module according to the present embodiment indicates not only a module in the computer program but also a module in a hardware configuration. For this reason, the present embodiment describes computer programs (program allowing a computer to execute each order, program executing a computer as each means, and program allowing a computer to carrying out each function), a system, and a method functioning as these modules. However, for convenience of explanation, 'storing', 'store', and words equivalent thereto are used, and in the case in which the embodiment is the computer program, these words mean storing the computer program in a storage apparatus or controlling to store the computer program in the storage apparatus. Further, the modules may be allowed to one-to-one correspond to the functions, but in mounting, one module may be allowed to be configured as one program, a plurality of modules may be allowed to be configured as one program, and to the contrary, one module may be allowed to be configured as a plurality of programs. Further, the plurality of modules may be allowed to be executed by one computer and according to a computer in a dispersion or parallel environment, one module may be allowed to be executed by the plurality of computers. Meanwhile, one module may be allowed to include another module. Further, hereinafter, a 'connection' is used even in the case of a logical connection (transfer and instruction of data, reference relationship between data, and the like), in addition to a physical connection. A 'predetermined' means that an object is defined prior to being processed, and even after processing according to the present embodiment starts as well as before the processing according to the present embodiment starts, if the object is not yet processed, a 'predetermined' is used including a meaning that object is defined depending on a situation and a state at that time or a situation and a state till then. When a plurality of 'predetermined values' is present, different values may be allowed and more than two values (of course, including all values) may be allowed to be the same. Further, a description having a meaning named 'if A, B is performed' is used as a meaning of 'when determined to be A

by determining whether or not it is A, B is performed'. However, the case in which it is unnecessary to determine whether or not it is A is ruled out.

A system or an apparatus includes not only a configuration in which a plurality of computers, hardware, an apparatus, and the like are connected to one other by a communication means such as a network (including communication connection of one-to-one correspondence), but also a case which is realized by one computer, hardware, an apparatus, and the like. 'Apparatus' and 'system' are used as a term having the same meaning. As a matter of course, a 'system' does not include components belonging to only a social 'structure' (social system) which is an artificial engagement.

Whenever each module performs processing or in the case in which a plurality of processings is performed within a module, targeted information is read from a storage apparatus for each processing, the processing is performed, and then the processed result is delivered to the storage apparatus. Therefore, a description about reading the targeted information from the storage apparatus before processing is performed and transferring the targeted information after processing to the storage apparatus may be omitted. Meanwhile, examples of the storage apparatus herein may include a hard disk, a random access memory (RAM), an external storage medium, a storage apparatus through a communication line, a register within a central processing unit (CPU), and the like.

An image processing system including an image processing apparatus according to the embodiment compares an image data with a reading data. As illustrated in an example of FIG. **1**, the image processing system includes an image generating module **110**, a recording module **120**, a reading module **130**, a data collection and position estimation module **140**, a block and movement amount calculating module **150**, and a comparison and contrast module **160**.

The image generating module **110** is connected to the recording module **120**, the data collection and position estimation module **140** and the comparison and contrast module **160**. The image generating module **110** converts a printing data **105** into a printing image **115** which is an image data. The conversion processing includes image conversion processing required for printing which includes rasterize and color space conversion. The image generating module **110** performs processing of converting the printing data **105** described as a PDL such as a portable document format (PDF) (registered mark) into a raster image (printing image **115**) which may be recorded on a medium (paper) with a printing machine and a printer. As a mounting form, there are dedicated hardware and software which is operated on a computer such as a personal computer (PC). The printing image **115** which is a processed result is delivered to the recording module **120**, the data collection and position estimation module **140** and the comparison and contrast module **160**.

The recording module **120** is connected to the image generating module **110** and the reading module **130**. The recording module **120** records the printing image **115** on a recording medium **125**. That is, an image of the image data is formed on the recording medium **125** which is a medium. This is so-called printing, or print out and the recording module **120** is realized as a printer which is an image forming apparatus.

The reading module **130** is connected to the recording module **120**, the data collection and position estimation module **140** and the comparison and contrast module **160**. The reading module **130** converts the printing image **115** on the recording medium **125** into a reading image **135** by photoelectric conversion, and the like. That is, the reading image **135** which is the data read from the recording medium **125** is generated. This is so-called scan out and the reading module **130** is realized as a scanner which is an image reading apparatus. The reading module **130** delivers the reading image **135** to the data collection and position estimation module **140** and the comparison and contrast module **160**.

The data collection and position estimation module **140** is connected to the image generating module **110**, the reading module **130**, and the block and movement amount calculating module **150**, and the comparison and contrast module **160**. The data collection and position estimation module **140** selects at least one block image extracted from one image of the printing image **115** and the reading image **135**. The data collection and position estimation module **140** sets a search range calculated from an error and searches for a matching position of the selected block image within the other image of the printing image **115** and the reading image **135**. And then, the data collection and position estimation module **140** estimates a corresponding position of the non-selected block image within the other image on the basis of the matching position of the selected block image within the other image. And, the data collection and position estimation module **140** delivers the estimated position (estimated value of deviation amount) to the comparison and contrast module **160**. First, the estimation processing of the corresponding position within the other image for the block image will be described with reference to FIGS. **3** and **4**. FIG. **3** is an explanation diagram illustrating the processing example in the data collection and position estimation module **140**.

1) As illustrated in an example of (a) and (b) of FIG. **3**, the printing data **115** and the reading data **135** are each segmented into a rectangle (hereinafter, referred to as block) to generate a printing block image **310** and a reading block image **320**. That is, into the block generated based on the error which may occur from the recording module **120** and/or the reading module **130**, the images of the printing image **115** and the reading image **135** are segmented to extract the block image. Meanwhile, as the block size herein, the block size **152** which is calculated by the block and movement amount calculating module **150** is used.

More specifically, the processing is performed as in the following.

into the rectangle generated based on the error which may occur from the recording module **120** and/or the reading module **130**, one image of the printing image **115** and the reading image **135** are segmented to extract the rectangle image. One image may be any of the printing image **115** and the reading image **135**. Hereinafter, the printing image **115** considered as one image and the reading image **135** considered as the other image will be mainly described. A block segmentation will be described with reference to FIG. **9**. FIG. **4** is an explanation diagram illustrating a processing example according to the present embodiment. In an example of (a) of FIG. **9**, a reference image **900***a* is segmented into 9×12 blocks. As a matter of course, a segmented number is changed depending on a block size and a size of the reference image **900***a*. Further, according to the relationship between the block size and the size of the reference image **900***a*, the segmented number may not be necessarily segmented into an integer number, but for example, a portion which is not occupied in one block may be added with a white image, and the like. Further, the data collection and position estimation module **140** accepts a block size **152** from the block and movement amount calculating module **150** and segments the reference image **900***a* into a block.

FIG. **10** is an explanation diagram illustrating a block example and enlargedly illustrates a block image **910***a* illustrated in an example of (a) of FIG. **9**. The block image **910***a*

has a size of $W_p \times H_p$. Further, coordinates of a central pixel **1010** of the block image **910***a* are set to be C_x and C_y.

2) As illustrated in an example of (c) of FIG. **3**, at least one set of the extracted block images is selected, and in the blocks (the printing image **115** and the reading image **135**) at the corresponding position, a difference absolute value between the printing image **115** and the reading image **135** is calculated for each pixel. For example, exclusive OR (EOR) processing may be performed for each pixel.

3) A position at which a sum (a total sum of the difference absolute values in each pixel within the block) of difference absolute values within the block is minimal is searched. Meanwhile, a search range A may be the same as the estimated value **145** of the displacement amount used in the comparison and contrast module **160**. The search range A may be different from it. The search range A may be defined from the movement amount **154** which is calculated by the block and movement amount calculating module **150**. Alternatively, the search range A may be a search range described below with reference to FIG. **6**.

In an example of FIG. **3**, a printing block image **310** is searched on a reading block image **320**. That is, the positions of the printing block image **310** and the reading block image **320** are changed in the search range A and the sum of difference absolute values in the positional relation is calculated. The positional relation between the rectangular images in which the calculated sum of difference absolute values is minimal is specified. As illustrated in an example of FIG. **4**, for the reading block image **420** within the reading image **400**, the printing block image **410** is searched. In the search range A, a positional relation **450** in which the sum of difference absolute values is minimal is obtained. The positional relation **450** is, for example, differences Δx and Δy of the central coordinates of the printing block image **410** and the reading block image **420**. An example in which the printing block image **310** is searched on the reading block image **320** is described herein, but as a matter of course, the reading block image **320** may be searched on the printing block image **310**. In this example, although the block images are cut out from both of the printing image and the reading image, the block images are cut out only from the printing image. In that case, the search range may be directly set into the other image as the reading image, and a position in which the sum of difference absolute values is minimal may be searched. Alternatively, the block images are cut out only from the reading image. In that case, the search range may be directly set into the other image as the printing image, and a position in which the sum of difference absolute values is minimal may be searched.

In this example, the search range A is calculated as in the following.

The data collection and position estimation module **140** determines the range of the movement amount defining the search range A, based on the error which may occur from the recording module **120** recording the image of the printing image **115** on the recording medium **125** and/or the reading module **130** reading the recording medium **125**, and the position within the image (whichever of the printing image **115** and the reading image **135** may be used). The 'errors which may occur from the recording module **120** or the reading module **130**' will be described below in the description of the block and movement amount calculating module **150**. For example, the data collection and position estimation module **140** increases the movement amount in accordance with the distance from the original point in the printing image **115** or the reading image **135**, and calculates the movement amount at the farthest point from the original point so that the movement amount by the affine transformation, which is the error that may occur from the recording module **120** or the reading module **130**, is maximal in the size of the printing image **115** or the reading image **135**. Meanwhile, the distance from the original point has the same value as the position of the block. The original point of the printing image **115** or the reading image **135** is a position at which the occurrence of the error of the recording module **120** or the reading module **130** is minimal, and means, for example, the coordinates of the upper left corner of the image. The 'farthest point from the original point' is the farthest position from the original point. The farthest position from the original point is a position at which the occurrence of the error of the recording module **120** or the reading module **130** is maximal, and means, for example, the coordinates of the lower right corner of the image. In detail, the data collection and position estimation module **140** increases the size of the search range A toward the direction of the coordinate of the lower right corner from the coordinate of the upper left corner. Further, the maximum size is defined by the maximum value of the 'errors which may occur from the recording module **120** or the reading module **130**', and is the movement amount **154** which is calculated by the block and movement amount calculating module **150**.

This will be described using an example of FIG. **6**. FIG. **6** is an explanation diagram illustrating an example of the size of the search range A based on the position within the image. an example of (a) of FIG. **13** illustrates an example of positions of an original point **610** (upper left corner) and a farthest point **690** (lower right corner) in an image **600**. Further, an example of (b) of FIG. **13** illustrates the relationship between a block **612** in the original point **610** and a search range A **614**. The search range A **614** is large by a predetermined value (0 or more), when comparing with the block **612**. An example of (c) of FIG. **13** illustrates the relationship between a block **692** in the farthest point **690** and a search range A **694**. The search range A **694** is a size which is defined by the movement amount **154** calculated by the block and movement amount calculating module **150**. Meanwhile, the sizes of the block **612** and the block **692** are the same as each other, and are the block size **152** calculated by the block and movement amount calculating module **150**. An example in which the upper left corner is defined as the original point and the lower right corner is defined as the farthest point is illustrated herein, but according to a nature of errors which may occur from the recording module **120** or the reading module **130**, whichever of the four points (lower right corner, upper right corner, lower left corner, and upper left corner) may be used. Herein, the rotation of the recording module **120** or the reading module **130** is generated based on the upper left corner and the case in which as the rotation is far from the upper left corner, the expansion and contraction has a great effect is described by way of example.

Next, the data collection and position estimation module **140** searches a matching position of the extracted rectangular image within the other image in the search range A using a position in which the sum of difference absolute values is minimal as a reference. For example, (b) of FIG. **9** illustrates an example of searching for the block image **910***a* illustrated in (a) of FIG. **9**. As illustrated in (b) of FIG. **9**, the data collection and position estimation module **140** searches for the block image **910***a* within a search range **950***b* which is a 'range of movement amount' within a reading image **400***b*. Meanwhile, the block image **910***b* within the reading image **900***b* corresponds to the block image **910***a* within the reference image **900***a*. Ideally, (when errors which may occur from the recording module **120** and the reading module **130** are 0), the defects are detected only by comparing the block image

910*a* with the block image **910***b*, but since the errors, which may occur from the recording module **120** and/or the reading module **130**, are actually present, the search is performed within the search range **950***b* considering the errors (the search range determined by the data collection and position estimation module **140**). Therefore, it is possible to find a position which matches the block image **910***a* within the reading image **900***b* without the need to search for the overall reading image **900***b*. The search range is an area formed as the vertical and horizontal movement amount with a rectangle of the other image being centered, including the rectangle of the other image in the same position as the rectangular position of said one image.

The search processing will be described with reference to FIG. **11**. FIG. **11** is an explanation diagram illustrating a processing example by the comparison and contrast module **160**. An example illustrated in FIG. **11** enlargedly illustrates the search range **950***b* illustrated in an example of (b) of FIG. **9**. The block image **910***a* of the reference image **900***a* moves by one pixel within the search range **950***b* of the reading image **900***b* to perform template matching such as exclusive OR processing. Further, as the result of the template matching, a relative position to the block image having a largest score which demonstrates most approximation within the search range becomes a displacement amount **620**. That is, the block image **910***b* corresponds to the block image **910***a* within the search range **950***b*, and as the result of performing the template matching of the block image within the search range **950***b* with the block image **910**; when a block image **1130** at a largest score position is extracted, the relative position becomes the displacement amount **1120**. Meanwhile, the comparison and contrast module **160** accepts an estimated value **145** of the displacement amount from the data collection and position estimation module **145**, thereby searching for the targeted block.

Meanwhile, the block in which the position at which the sum of difference absolute values is minimal may be plural is previously excluded from a target. For example, there are a block of which the whole surface is compactly painted with the same color (for example, white, black, and the like) (a case may be included that although the whole surface is not painted with the exact same color, the variation in the pixel values of the whole surface is below a predetermined value), a block in which only one line is drawn, a block in which a parallel line formed of a plurality of lines is drawn, a block in which the patterns (substantially same patterns) are regularly drawn, and the like. The blocks are not suitable to estimate the search range **145**. It is the reason why the corresponding position can not be determined unambiguously, the position of the non-selected block can not be estimated, or the estimated position of the non-selected block has a large error. Timing for excluding from the target may be at the time of selecting the block. The timing may be at the time of estimating the position within the other image after selecting block and searching the corresponding position. Here, the timing for excluding from the target is at the time of selecting the block reduces a calculation amount for unnecessary searching. In addition, the selecting and searching of the block indicates a distance between the rectangular images in which the sum of difference absolute vales is minimal is larger than or equals to a predetermined value, the positional relationship for the selected block is excluded from a base for the position estimation of the other non-selected blocks.

Next, the estimation of a position within the other image for the block which is not selected by the data collection and position estimation module **140** will be described wither reference to FIG. **5**. FIG. **5** is an explanation diagram illustrating the processing example in the data collection and position estimation module **140**. As illustrated in an example of (a) of FIG. **5**, in the block (diagonal block in (a) of FIG. **5**) within a printing image **510**, the positional relation in which the sum of difference absolute vales is minimal is calculated. Meanwhile, the block (white block in (a) of FIG. **20**) excluded from the target is not used in the processing of position estimation.

The data collection and position estimation module **140** calculates a plane in a feature space defined by the positional relation between the block images and estimates the positions of the non-selected blocks based on the plane. In detail, the plane of the displacement amount is calculated from the positional relation in which the sum of difference absolute values is minimal to calculate the displacement amount depending on the positions of each block.

That is, the following processing is carried out. The positional relation Δx and Δy is plotted in the feature space. As the feature space, there is, for example, a three-dimensional space in which an X axis, a Y axis, and Δx or Δy as an axis of the image are defined. Herein, the x axis and the y axis are central coordinates of the block. As the feature space, a four-dimensional space in which an x axis, a y axis, a Δx axis, and a Δy axis of the image are defined may be used, and any space including Δx or Δy as an axis may be used. The plane configured by the plot is calculated. For example, the plane may be a displacement amount Δx plane **520** in the example of (a) of FIG. **5** and a displacement amount Δy plane **530** in the example of (b) of FIG. **5**. As a matter of course, all the plots are not necessarily present on the plane, and a plane estimated from these plots is sufficient to be calculated using the existing method.

The displacement amount in all the blocks within the image may be estimated using the plane indicating the displacement amount. In detail, the positions of each block are substituted into Equations $\Delta x=a_1x+b_1y\,c_1$ and $\Delta y=a_2x\,b_2y+c_2$ representing the plane to estimate the displacement amount in each block. Here, the estimation of the displacement amount needs to be performed to at least non-selected block images. When this processing is executed in sequential processing, a case that only the non-selected block images are specified is processed more quickly than a case that all the block images are specified. This is because the calculation amount for the estimation of the displacement amount is reduced. When this processing is executed in parallel processing using such as a multi-core CPU and a GPU, a case that all the block images are uniformly specified is processed more quickly than a case that a step for determining as to whether a block image is selecting target or not is further added.

Next, the data collection and position estimation module **140** searches for each block image, a corresponding position within the other image based on the displacement amount estimated by the method discussed above. The search range is set on the basis of the estimated displacement amount, the template matching is performed, and the position having the most proximity between the images within the search range is searched. Template matching similar to the template matching discussed above can be used as this template matching. Here, the searching is performed to at least non-selected block images. When this processing is executed in sequential processing, a case that only the non-selected block images are specified is processed more quickly than a case that all the block images are specified. This is because the calculation amount for the searching is reduced. When this processing is secondly executed in parallel processing using such as a multi-core CPU and a GPU, a case that all the block images are uniformly specified is processed more quickly than a case that a step for determining as to whether a block image is

target or not is further added. The search range may be determined in a similar way to the method for determining the search range discussed above. Since the position for the non-selected blocks has been estimated, smaller range would be employed as the search range in this processing. It reduces the calculation amount for difference extraction.

The comparison and contrast module **160** is connected to the image generating module **110**, the reading module **130**, and the data collection and position estimation module **140**. The comparison and contrast module **160** compares and contrast the printing image **115** with the reading image **135** to detect whether defects are present and an area in which defects occurs. That is, the comparison and contrast module **160** accepts the printing image **115** and the reading image **135**. The reading image **135** is read from the recording medium **125** on which an image of the printing image **115** is formed. That is, the comparison and contrast module **160** receives the original printing image **115** which is a print out target and the reading image **135** which is obtained by printing out the printing image **115** and scanning the printed out recording medium **125**. This is to check whether defects occurring by the recording module **120** and the reading module **130** are present. Herein, the defect is called noise and ideally, completely matches the printing image **115** and the reading image **135**. However, the defects occur due to maintenance situations of the recording module **120** and the reading module **130**, and the like. Meanwhile, errors may occur in the recording module **120** and the reading module **130**. Herein, an 'error which may occur' is an error which is tolerable in a design specification of the recording module **120** and the reading module **130**. Examples of the error include, in detail, an affine transformation of expansion and contraction, rotation, and movement. As the error, for example, when the design specification in which the rotation is not generated at an x degree or more is realized (a design target is achieved), the rotation below the x degree may be generated.

Therefore, the comparison and contrast module **160** is to extract the defects (for example, black pixel mixing of 3 pixels or more) except for errors which may occur from the recording module **120** and the reading module **130**. That is, it is checked whether defects other than the errors, which are tolerable in the design specification, occur, to specify positions at which the defects occur, thereby assisting the maintenance of the recording module **120** and the reading module **130**.

Next, the comparison and contrast module **160** accepts the search result from the data collection and the position estimation module **140** and compares the extracted rectangular image with the image at the corresponding portion within the other image (the image of the search result). That is, the most matching position between the rectangular image on the printing image side and the rectangular image on the reading image side are overlapped to extract differences. The 'search result' is a result of extracting a position at which one image best matches the other image by comparing the rectangular images within the one image, in the search range of the other image. A difference between the position and a position of the rectangular image may be set to be the displacement amount. The 'compare' may include using the search result. That is, since the search result is the best matched case, the matched degree may be set as a defect detection result **165**. Further, the defect detection result **165** may include the displacement amount in addition to the matched degree.

This will be described with reference to FIG. **7**. FIG. **7** is an explanation diagram illustrating a processing example of the defect detection by the comparison and contrast module **160**. A printing block image **710** illustrated in an example of (a) of FIG. **7** is the block image within the printing image **115**, a reading block image **720** illustrated in an example of (b) of FIG. **7** is the block image within the reading image **135**, and a difference block image **730** illustrated in an example of (c) of FIG. **7** is a difference (result of exclusive OR processing) between the printing block image **710** and the reading block image **720**. The comparison and contrast module **160** generates difference images for each block and detects the defects within the difference images. As the defects, for example, the defect that one side of a circumscribed rectangle has a size of a predetermined range (for example, from three pixels to five pixels, and the like) may be detected.

The block and movement amount calculating module **150** is connected to the data collection and position estimation module **140**. The block and movement amount calculating module **150** calculates the block size **152** and the movement amount **154** based on the error which may occur from the recording module **120** and/or the reading module **130**. Further, the block size **152** and the movement amount **154** are delivered to the data collection and position estimation module **140**. Examples of the error of the recording module **120** or the reading module **130** include the affine transformation in an image forming apparatus or an image reading apparatus. In a detailed example, the error includes an expansion and contraction rate, a rotation angle, and the like. Meanwhile, the processing by the block and movement amount calculating module **150** is sufficient to be carried out prior to carrying out the processing by the data collection and position estimation module **140** and the block size **152** and the movement amount **154** may be previously calculated and stored in the data collection and position estimation module **140**. Further, to cope with the errors from the recording module **120** and the reading module **130** which are used at that time, the block and movement amount calculating module **150** may accept errors from the recording module **120** and the reading module **130** to calculate the block size **152** and the movement amount **154** each time.

The block size **152** is set so that a pixel shift between the rectangular image of one image and the rectangular image of the other image is within one pixel due to the affine transformation. Meanwhile, the calculation of the block size **152** will be described with reference to an example of FIG. **13**.

In the size of the printing image **115** or the reading image **135**, the movement amount **154** due to the affine transformation is defined to be maximal. The movement amount **154** is to form the search range **950***b*. FIG. **7** is an explanation diagram illustrating a relation example between the block image **910***a* and the search range **950***b*. The movement amount **154** includes, in detail, an upper direction movement amount, a lower direction movement amount, a left direction movement amount, and a right direction movement amount.

A length (block height) of the block image **910***a* is L_a+1+L_b and is H_p illustrated in an example of FIG. **5**.

A width (block width) of the block image **910***a* is L_l+1+L_r and is W_p illustrated in the example of FIG. **5**.

The length (height of the search range) of the search range **950***b* is $H_p+L_a+L_b$. L_a is the upper direction movement amount. L_b is the lower direction movement amount.

The width (width of the search range) of the search range **950***b* is $W_p+L_l+L_r$. L_l is the left direction movement amount. L_r is the right direction movement amount.

Meanwhile, the calculation of the movement amount **154** will be described with reference to examples of FIGS. **14** and **15**.

The movement amount **154** indicates a maximum value within the search range in the image. The data collection and position estimation **140** determines the estimated value **145** of

the displacement amount using the movement amount **154** on the basis of the position of the block within the image.

a processing example according to the present embodiment is described.

Firstly, the image generating module **110** converts the printing data **105** into an image to generate the printing image **115**.

Next, the recording module **120** records the printing image **115** on the recording medium **125**.

Next, the reading module **130** reads the recording medium **125** on which the printing image **115** is recorded. the read result is the reading image **135**.

Next, the data collection and position estimation module **140** obtains data for determining the estimated value **145** of the movement amount.

Next, the data collection and position estimation module **140** estimates the movement amount of each block.

The comparison and contrast module **160** compares and contrasts the conversion image (printing image **115**) with the reading image **135** to detect an area in which defects occurs.

FIG. **2** is a flow chart illustrating a processing example according to the embodiment.

In step S**202**, at least one image of the image of the printing data and the image of reading data is segmented. In this segmenting method, the image is segmented to have a size calculated using an error (for example, as the error becomes larger, the size becomes smaller).

In step S**204**, the search range is determined for at least one of the segmented images. The search range is determined to have a size calculated using the error (for example, as the error becomes large, the size becomes larger).

In step S**206**, the corresponding position within the other image is specified. Specifically, the segmented image is overlapped into the other image to acquire difference for each pixel. The addition of the difference absolute value is performed while changing the position of the image within the search range. The position having the smallest difference is regarded as the corresponding position.

In step S**208**, the corresponding position within the other image for another segmented image is estimated on the basis of the specified corresponding position. Specifically, the shift amount is drawn in the plane between the corresponding position and the initial position. The shift degree of the other segmented image is estimated from the plane and the position of the segmented image relative to the segment source.

In step S**210**, for the other segmented image, the corresponding position within the other image is specified on the basis of the estimated position. The search range in step S**210** may be the same as that of step S**204**, a narrower search range than the search range determined in step S**204** can be employed. This is because the corresponding position is closer for the searched segmented image due to the search beginning from the position estimated in step S**208**. The narrower search range reduces the calculation amount of difference calculation for specifying the corresponding position.

In step S**212**, the compared result at the specified positions is output. The different at the time of specifying the corresponding position may be output as the compared result as it is. The difference may be output by processing the image (for example, the difference is emphasized).

FIG. **8** is a flow chart illustrating a processing example in which the block and movement amount calculating module **150** calculates the block size **152** and the movement amount **154**.

In step S**802**, the expansion and contraction rate and the rotation angle (skew angle) which may be generated from the recording module **120** and the reading module **130** are acquired.

In step S**804**, the block size is calculated.

In step S**806**, the movement amount is calculated.

In step S**808**, the block size **152** and the movement amount **154** are delivered to the position estimation module **140** and the comparison and contrast module **160**.

FIG. **13** is an explanation diagram illustrating a processing example of calculating the block size **152**. When both the rotation and the expansion and contraction by the recording module **120** and the reading module **130** are generated in the worst state, the block size is set so that when a center of the block of the printing image **115** coincides with a center of the block of the reading image **135**, the pixel shift at each corner is within 1 pixel.

The example of FIG. **13** illustrates how a point **1350** within the printing image **115** is shifted by the errors from the recording module **120** and the reading module **130**.

The point **1350** moves to a point **1360** by the movement (at the time of maximum contraction in both scanning directions) **1355** due to expansion and contraction. Further, the point **1350** moves to a point **1370** by a movement (counterclockwise) **1365** due to the skew. This corresponds to the case in which the contraction is maximal (smallest) and the counterclockwise rotation is maximal.

The point **1350** moves to a point **1340** by the movement (at the time of maximum expansion in the both scanning directions **1345** due to the expansion and contraction. Further, the point **1350** moves to a point **1330** by a movement (clockwise) **1335** due to the skew. This corresponds to the case in which the expansion is maximal (largest) and the clockwise rotation is maximal.

(1) When in both scanning directions, the contraction is maximal (x-axis direction magnification: r_1 and y-axis direction magnification: r_2) and the skew is maximal (counterclockwise, rotation angle α), if the movement amount of a point on a diagonal line which has the maximum movement amount based on a center of a block as an original point is calculated as (1, 1), the movement amount is represented by the following Equation (1).

[Equation 1]

$$\begin{bmatrix} \cos(\alpha) & -\sin(\alpha) \\ \sin(\alpha) & \cos(\alpha) \end{bmatrix} \begin{bmatrix} r_1 \\ r_2 \end{bmatrix} = \begin{bmatrix} x_1 \\ y_1 \end{bmatrix} \quad (1)$$

A difference Δx of x in the case of a straight line passing through the point and y=1 as an original straight line is calculated. In the example of FIG. **8**, the difference Δx is defined by a straight line passing through the point **1350**, the original point, and the point **1370** and a straight line of which y=1.

(2) Meanwhile, when in both scanning directions, the expansion is maximal (x-axis direction magnification: r_3 and y-axis direction magnification: r_4) and the skew is maximal (clockwise, rotation angle β), if the movement amount of a point on a diagonal line which has the maximum movement amount based on a center of a block as an original point is calculated as (1, 1), the movement amount is represented by the following Equation (2).

[Equation 2]

$$\begin{bmatrix} \cos(\beta) & \sin(\beta) \\ -\sin(\beta) & \cos(\beta) \end{bmatrix} \begin{bmatrix} r_3 \\ r_4 \end{bmatrix} = \begin{bmatrix} x_2 \\ y_2 \end{bmatrix} \quad (2)$$

A difference Δy of y in the case of a straight line passing through the point and x=1 as an original straight line is calculated. In the example of FIG. **8**, the difference Δy is defined by a straight line passing through the point **1350**, the original point, and the point **1330** and a straight line of which x=1. (3) y' and x' in which Δx and Δy are 1.4 are calculated. Further, if the width and height of the block are W and H, the width and height are represented by the following Equation (3).

[Equation 3]

$$W=2*\text{ceil}(x')+1,\ H=2*\text{ceil}(y')+1 \quad (3)$$

Meanwhile, ceil( ) is a function which rounds off below the decimal point.

Therefore, the block size **152** (W and H of Equation (3)) may be calculated. For example, the width and height of the block each become 100 pixels and 110 pixels, and the like.

Next, a processing example of calculating the movement amount **154** (size of search range) will be described using examples of FIGS. **14** and **15**.

In the case in which all of the rotation, the expansion and contraction, and the movement by the recording module **120** and the reading module **130** are worst, the movement amount **154** is set to be able to consider the movement amount at the lower right corner in a certain paper size (for example, A elongation paper). Meanwhile, in the following coordinates, an upper left corner is defined to be an original point, a right direction and a lower direction are defined to be a positive value direction, and the rotation angle in a clockwise direction is defined to be a positive value direction.

Under the condition in which the movement amount in the upper right direction is maximal, the movement amount of the lower right corner (for example, coordinates (3897 and 5763) at 300 dpi in the A3 elongation paper), which has the maximum movement amount based on the upper left corner in a certain paper size as the original point, is calculated as represented by the following Equation (4).

[Equation 4]

$$M=M_{skew}+M_{size}+M_{shift} \quad (4)$$

However, M_{skew} represents the movement amount by the skew, M_{size} represents the movement amount by the expansion and contraction, and M_{shift} represents the movement amount by the shift.

Here, the M_{skew}, the M_{size}, and the M_{shift} each are represented by the following Equations (5), (6), and (7).

[Equation 5]

$$M_{skew}=\begin{cases} 3897-\{3897\times\cos(\gamma)-5763\times\sin(\gamma)\}= \\ M_{askew}\ \text{pixel(main scanning direction)} \\ 5763-\{3897\times\sin(\gamma)+5763\times\cos(\gamma)\}= \\ M_{bskew}\ \text{pixel(sub-scanning direction)} \end{cases} \quad (5)$$

[Equation 6]

$$M_{size}=\begin{cases} 3897\times r_5-3897=M_{asize}\ \text{pixel(main scanning direction)} \\ 5763\times r_6-5763=M_{bsize}\ \text{pixel(sub-scanning direction)} \end{cases} \quad (6)$$

-continued

[Equation 7]

$$M_{shift}=\begin{cases} s_1\div 25.4\times 300=M_{ashift}\ \text{pixel(main scanning direction)} \\ s_2\div 25.4\times 300=M_{bshift}\ \text{pixel(sub-scanning direction)} \end{cases} \quad (7)$$

Meanwhile, γ represents the rotation angle, r_5 and r_6 represent the expansion and contraction rate, and s_1 and s_2 represent the movement amount.

Therefore, γ, r_5 and r_6, and s_1 and s_2 are represented by the follow Equation (8).

[Equation 8]

$$M=\begin{cases} M_{askew}+M_{asize}+M_{ashift}=M_a\ \text{pixel(main scanning direction)} \\ M_{bskew}+M_{bsize}+M_{bshift}=M_b\ \text{pixel(sub-scanning direction)} \end{cases} \quad (8)$$

This will be described using an example of FIG. **14**. FIG. **14** is an explanation diagram illustrating the processing example of calculating the movement amount.

A point **1450** moves to a point **1460** by a movement (maximal in the upper right direction) **1455** due to the shift. Further, the point **1450** moves to a point **1470** by a movement (at the time of the maximum expansion in a main scanning direction and the maximum contraction in a sub-scanning direction) **1465** due to the expansion and contraction. Further, the point **1450** moves to a point **1480** by a movement (counterclockwise) **1475** due to the skew. That is, at the farthest point (lower right corner) from an original point **1410** (upper left corner in FIG. **9**) of an image **1400**, the maximum movement amount in the upper direction and the right direction is calculated.

Meanwhile, under the condition in which the movement amount in the lower left direction is maximal, the movement amount of the lower right corner (for example, A3 elongation paper), which has the maximum movement amount based on the upper left corner in a certain paper size as the original point, is calculated as represented by the following Equations (9), (10), and (11).

[Equation 9]

$$M_{skew}=\begin{cases} 3897-\{3897\times\cos(\theta)-5763\times\sin(\theta)\}= \\ M_{cskew}\ \text{pixel(main scanning direction)} \\ 5763-\{3897\times\sin(\theta)+5763\times\cos(\theta)\}= \\ M_{dskew}\ \text{pixel(sub-scanning direction)} \end{cases} \quad (9)$$

[Equation 10]

$$M_{size}=\begin{cases} 3897\times r_7-3897=M_{csize}\ \text{pixel(main scanning direction)} \\ 5763\times r_8-5763=M_{dsize}\ \text{pixel(sub-scanning direction)} \end{cases} \quad (10)$$

[Equation 11]

$$M_{shift}=\begin{cases} s_3\div 25.4\times 300=M_{cshift}\ \text{pixel(main scanning direction)} \\ s_4\div 25.4\times 300=M_{dshift}\ \text{pixel(sub-scanning direction)} \end{cases} \quad (11)$$

Meanwhile, θ represents the rotation angle, r_7 and r_8 represent the expansion and contraction rate, and s_3 and s_4 represent the movement amount.

Therefore, θ, r_7 and r_8, and s_3 and s_4 are represented by the follow Equation (12).

[Equation 12]

$$M = \begin{cases} M_{cskew} + M_{csize} + M_{cshift} = M_c \text{ pixel(main scanning direction)} \\ M_{dskew} + M_{dsize} + M_{dshift} = M_d \text{ pixel(sub-scanning direction)} \end{cases} \quad (12)$$

This will be described using an example of FIG. **10**. FIG. **10** is an explanation diagram illustrating the processing example of calculating the movement amount.

The point **1450** moves to a point **1440** by a movement (maximal in the lower left direction) **1445** due to the shift. Further, the point **1450** moves to a point **1430** by a movement (at the time of the maximum contraction in the main scanning direction and the maximum expansion in the sub-scanning direction) **1435** due to the expansion and contraction. Further, the point **1450** moves to a point **1420** by a movement (clockwise) **1425** due to the skew. That is, at the farthest point (lower right corner) from the original point **1410** (upper left corner in FIG. **10**) of the image **1400**, the maximum movement amount in the upper direction and the left direction is calculated.

From the above description, the upper direction maximum value, the lower direction maximum value, the left direction maximum value, and the right direction maximum value of the movement amount are each calculated. For example, the maximum values each are 67.41 pixels, 95.99 pixels, 58.73 pixels, and 62.47 pixels, and the movement amounts in the vertical and horizontal directions of the block each are a minimum of 68 pixels, 96 pixels, 59 pixels, and 63 pixels. Meanwhile, actually, since the recording module **120** and the reading module **130** may be out of the specification (spec over), the movement amounts may be set to be large by a predetermined value. This value indicates movement amount from the original point **1410** to the farthest point **1450**. The movement amount (search range) at the position except for the point **1450** may be determined by the data collection and position estimation module **140** on the basis of the position and the movement amount at the point **1450**.

A hardware configuration example of the image processing apparatus according to the present embodiment will be described with reference to FIG. **16**. The configuration illustrated in FIG. **16** is configured by, for example, a personal computer (PC), and the like, and a hardware configuration example including a data reading unit **1617** such as a scanner and a data output unit **1618** such as a printer is illustrated.

A central processing unit (CPU) **1601** is a control unit which carries out processing according to computer programs which describe an execution sequence of each module of various modules described in the above-mentioned embodiments, that is, the data collection and position estimation module **140**, the comparison and contrast module **160**, the image generating module **110**, the block and movement amount calculating module **150**, and the like.

A read only memory (ROM) **1602** stores programs, operation parameters, and the like which are used by the CPU **1601**. A random access memory (RAM) **1603** stores programs which are used in the execution by the CPU **1601**, parameters appropriately changed in the execution, and the like. These components are connected to each other by a host bus **1604** which is configured of a CPU bus, and the like.

The host bus **1604** is connected to an external bus **1606**, such as a peripheral component interconnect/interface) bus, via a bridge **1605**.

A pointing device such as a keyboard **1608** and a mouse is an input device which is operated by an operator. As a display **1610**, there are a liquid crystal display device, a cathode ray tube (CRT), and the like, and the display **1610** displays various types of information as a text or image information.

A hard disk drive (HDD) **1611** includes a hard disk and drives the hard disk to record or reproduce programs or information which is executed by the CPU **1601**. The hard disk stores the printing data **105**, the printing image **115**, the reading image **135**, the block size **152**, the movement amount **154**, and the estimated value **145** of the displacement amount, and the like. Further, the hard disk stores various computer programs such as other various data processing programs.

A drive **1612** reads data or programs which are recorded in removable recording media **1613**, such as a magnetic disk, an optical disk, and a magneto-optical disk which are mounted therein or a semiconductor memory, and supplies the data or the programs to the RAM **1603** connected via an interface **1607**, the external bus **1606**, the bridge **1605**, and the host bus **1604**. The removable recording medium **1613** may also be used as a data recording region like the hard disk.

A connection port **1614** is a port which connects an external connection equipment **1615** and has connection units, such as USB and IEEE1394. The connection port **1614** is connected to the CPU **1601** via the interface **1607**, the external bus **1606**, the bridge **1605**, the host bus **1604**, and the like. A communication unit **1616** is connected to a communication line to carry out the data communication processing with the outside. The data reading unit **1617** is, for example, a scanner and carries out reading processing of a document. The data output unit **1618** is, for example, a printer and carries out output processing of document data.

Meanwhile, the hardware configuration of the image processing apparatus illustrated in FIG. **22** represents one configuration example, and the present embodiment is not limited to the configuration illustrated in FIG. **22**, but any configuration which may carry out the modules described in the present embodiments may be used. For example, some modules may be configured of dedicated hardware (for example, application specific integrated circuit (ASIC), and the like), and may have a form that the modules are connected to each other by the communication line within the external system, and the systems illustrated in FIG. **22** may be connected to each other by a plurality of mutual communication lines to perform the cooperative operation. Further, the system may be embedded in a copier, a facsimile, a scanner, a printer, a multi-function printer (image processing apparatus having at least two functions of the scanner, the printer, the copier, the facsimile, and the like), and the like.

Meanwhile, the present embodiment may be the image processing apparatus including the data collection and position estimation module **140** and the comparison and contrast module **160** and may include the block and movement amount calculating module **150**, the reading module **130**, the recording module **120**, and the image generating module **110**.

Meanwhile, the aforementioned programs may be stored and provided in the recording medium and may be provided by the communication means. In this case, for example, the aforementioned programs may be understood as the invention of 'computer readable recording medium recorded with program'.

The 'computer readable recording medium recorded with program' means a recording medium which may be readable with a computer recorded with programs which are used for install and execution of the programs, distribution of the programs, and the like.

Meanwhile, examples of the recording medium may include a digital versatile disc (DVD), 'DVD-R, DVD-RW, DVD-RAM, and the like' which are standards set in a DVD forum, 'DVD+R, DVD+RW, and the like' which are stan-

dards set in DVD+RW, a compact disc (CD), a Blu-ray (registered mark) disc such as a read only memory (CD-ROM), a CD recordable (CD-R), and CD rewritable (CD-RW), a magneto-optical disc (MO), a flexible disc (FD), a magnetic tape, a hard disk, a read only memory (ROM), an electrically erasable and programmable read only member (EEPROM (registered mark)), a flash memory, a random access memory (RAM), a secure digital (SD) memory card, and the like.

The programs or some of the programs may be recorded and stored in the recording medium or may be distributed. Further, the programs may be transmitted by using communication, for example, a transmission medium such as a wired network, a wireless communication network, or a combination thereof which is used in a local area network (LAN), a metropolitan area network (MAN), a wide area network (WAN), the Internet, the Intranet, the Extranet, and the like, and may be carried on a carrier wave to be carried.

In addition, the programs may be a part of other programs and may be recorded in the recording medium along with separate programs. Further, the programs may be separately recorded in a plurality of recording media. Further, if the programs may be recovered, the programs may be recorded in any aspect such as compression and encryption.

The foregoing description of the exemplary embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments and with the various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.

What is claimed is:

1. An image processing apparatus, comprising:

a processor;

an acceptance unit, operable on the processor, that accepts image data and reading data read by an image reading apparatus from a medium on which an image of the image data is formed by an image forming apparatus;

an extraction unit, operable on the processor, that extracts rectangular images by segmenting one image of the image data and the reading data to have a size based on a tolerable error which occurs from the image forming apparatus and/or the image reading apparatus, the tolerable error being predetermined in design specification of the image forming apparatus and the image reading apparatus;

a first searching unit, operable on the processor, that searches for a matching position of a selected rectangular image in the other image of the image data and the reading data within a search range, the selected rectangular image being selected from at least one of the rectangular images, and the search range being set from the tolerable error;

an estimation unit, operable on the processor, that estimates a matching position of a rectangular image in the other image on the basis of the matching position of the selected rectangular image in the other image;

a second searching unit, operable on the processor, that searches for a matching position of the other rectangular image in the other image using the matching position estimated by the estimation unit as a reference; and

a comparison unit, operable on the processor, that compares the rectangular image extracted by the extraction unit with a corresponding rectangular image in the other image.

2. The image processing apparatus of claim **1**,

wherein the estimation unit estimates the matching position of the rectangular image except the selected rectangular image in the other image.

3. The image processing apparatus of claim **1**,

wherein the second searching unit searches for the matching position of the other rectangular image in the other image in a narrower search range than the search range of the first searching unit.

4. The image processing apparatus of claim **1**,

wherein the selected image is not a rectangular image of which the whole surface is compactly painted with the same color, a rectangular image in which only one line is drawn, a rectangular image in which a parallel line formed of a plurality of lines is drawn, nor a rectangular image in which patterns are regularly drawn.

5. The image processing apparatus of claim **1**,

wherein the second searching unit does not use the matching position of the selected rectangular image shifts over a predetermined value as the reference.

6. The image processing apparatus of claim **1**,

wherein the error is obtained from an affine transformation in the image forming apparatus or the image reading apparatus, and a size of the rectangle is set so that a pixel shift between the rectangular image of said one image and the corresponding rectangular image of the other image is within one pixel due to the affine transformation.

7. The image processing apparatus of claim **1**,

wherein the estimation unit calculates a plane determined by the positions of the selected rectangular images, and the estimation unit estimates the position of the rectangular image in the other image which is not selected by the first searching unit on the basis of the plane.

8. A non-transitory computer readable medium storing a program causing a computer to execute a process for image processing, the process comprising:

accepting image data and reading data read by an image reading apparatus from a medium on which an image of the image data is formed by an image forming apparatus;

extracting rectangular images by segmenting one image of the image data and the reading data to have a size based on a tolerable error which occurs from the image forming apparatus and/or the image reading apparatus, the tolerable error being predetermined in design specification of the image forming apparatus and the image reading apparatus;

searching for a matching position of a selected rectangular image in the other image of the image data and the reading data within a search range, the selected rectangular image being selected from at least one of the rectangular images, and the search range being set from the tolerable error;

estimating a matching position of a rectangular image in the other image on the basis of the matching position of the selected rectangular image in the other image;

searching for a matching position of the other rectangular image in the other image using the estimated matching position as a reference; and

comparing the extracted rectangular image with a corresponding rectangular image in the other image.

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